EFFECT OF PALM OIL FUEL ASH (POFA) TO STEEL FIBRE CONCRETE TOWARDS DRYING SHRINKAGE AND HEAT OF HYDRATION

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
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DEDICATION

Praise be to Allah S.W.T the Lord of the World

Who says (interpretation of the meaning)

"If you are grateful, I will give you more"

[Quran, Ibrahim 14:7]

I dedicated this research to my family especially

Mr. Md Ishak Bin Said and Mrs. Abadaa Binti Azmi,

Rusyda Elya, Rifaie Aliyah, Izzah Radiah and Muhammad Ikhwan

for giving me endless support and love.

And to my supervisor, Mr. Fadzil Mat Yahaya and all friends

for their endless help, patience and encouragement.

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ABSTRAK

Bahan Pozzolan adalah bahan yang terdiri daripada silika atau alumina. Pozzolan dengan kehadiran air boleh bertindak balas dengan kalsium hidroksida ($Ca(OH)_2$) untuk membentuk gel Kalsium-Silicate-Hydrate gel (CSH gel) yang bertindak terhadap kekuatan didalam konkrit. Bahan pozzolana dihasilkan oleh pembakaran sisa dari bahan semula jadi atau tiruan. Dalam kajian ini, abu kelapa sawit dikenali sebagai POFA digunakan sebagai bahan pozzolana di dalam konkrit. POFA adalah produk daripada kilang janakuasa dimana bahan buangan kelapa sawit seperti serat kelapa sawit dan tandan buah kosong dibakar untuk menjana kuasa elektrik. Saiz POFA yang digunakan adalah 63μm dan peratus POFA bagi menggantikan sebahagian daripada simen didalam konkrit gentian keluli yang digunakan adalah 10%, 20% dan 30% POFA mengikut berat simen yang digunakan untuk memerhati tindakbalas POFA sebagai pengganti simen kepada konkrit gentian keluli dalam mengurangkan suhu semasa penghidratan dan pengecutan pengeringan disebabkan oleh peratus yang berlainan daripada sebahagian pengganti simen di dalam konkrit gentian keluli. Hasil daripada ujian penghidratan panas menunjukkan bahawa POFA sebagai sebahagian pengganti simen terhadap konkrit gentian keluli mengurangkan jumlah suhu dan melambatkan masa bagi suhu puncak berlaku iaitu pada 30% POFA yang terkandung di dalam konkrit gentian keluli sebagai pengganti simen. Selain itu, hasil ujian pengecutan pengeringan menunjukkan bahawa konkrit yang mengandungi 30% daripada POFA sebagai sebabahagian daripada pengganti simen menunjukkan pengecutan yang lebih sedikit berbanding sampel lain. Kajian ini menunjukkan bahawa POFA adalah bermanfaat terutamanya dalam pembinaan konkrit gentian keluli sebagai sebahagian daripada pengganti simen.

ABSTRACT

Pozzolan material is material that consist of siliceous or aluminous. Pozzolan in the presence of moisture can react with calcium hydroxide ($Ca(OH)_2$) to form Calcium-Silicate-Hydrate gel (CSH gel) that responsible for the strength in cement based material. Pozzolanic material are produced by combustion of the waste from natural or artificial material. In this study, Palm Oil Fuel Ash (POFA) was utilized as pozzolanic material in concrete. POFA is by product from biomass product of power plant whereby oil palm residue such as fibre, shells and empty fruit bunches are burnt to generate electricity. The size of POFA is 63µm and Portland cement type 1 was partial replace by 10%, 20% and 30% of POFA by weight of cement used in order to observe the behavior of POFA as a cement replacement to steel fibre concrete in reducing temperature during hydration and drying shrinkage due to different percentage of partial cement replacement. The result of heat of hydration tests revealed that POFA as a partial cement replacement towards steel fibre concrete reduces the amount of temperature and delay the time which the peak temperature occurs at 30% of POFA as a cement replacement. Other than that, the drying shrinkage test result showed that the steel fibre concrete containing 30% of POFA as a partial cement replacement was much less shrinkage compared to other sample. This study implies that POFA is a good and beneficial especially in the construction of steel fibre concrete as a cement replacement.

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LIST OF SYMBOLS

%	Percentage
μm	Micrometre
mm^2	Millimetre Square
m^3	Meter Cube
g	Gram
°C	Degree Celsius

LIST OF ABBREVIATIONS

UMP	Universiti Malaysia Pahang
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
ASTM	American Society for Testing and Materials
POFA	Palm Oil Fuel Ash
OPC	Ordinary Portland Cement
CO_2	Carbon Dioxide
SiO_2	Silicon Dioxide
Al_2O_3	Aluminium Oxide
CaO	Calcium Oxide
MgO	Magnesium Oxide
SO_3	Sulphur Trioxide
Na_2O	Sodium Oxide
K_2O	Potassium Oxide
LOI	Loss on Ignition
CSH	Calcium-Silicate-Hydrate
MPa	Mega Pascal
Min	Minute

CHAPTER 1

INTRODUCTION

1.1 Background

Cement is an important material to produce a concrete. Figure 1.1 shows that Malaysia's cement production fluctuated since 1986 to 2016 but for overall trending, it increased from year 1986 to 2016. The growth of cement production generally because of the demand from the construction industry as it one of the important material in construction.

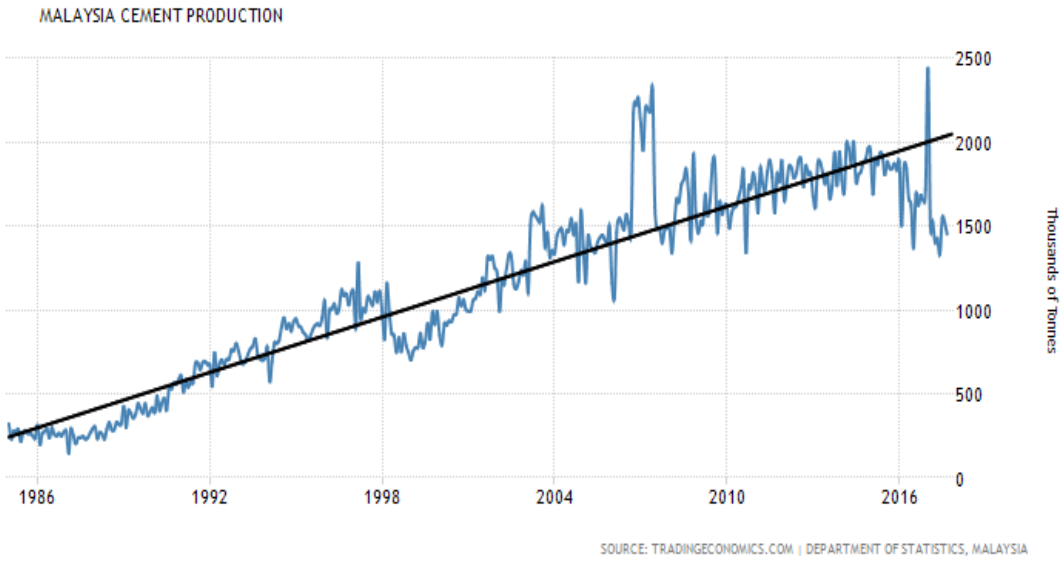

Figure 1.1 Malaysia Cement Production

Source: ("Malaysia Cement Production," 2018)

Concrete refers to a mixture of cements, aggregates and sand. It defined as an important material in construction's world especially to construct a building, bridge and pavement. A good quality of concrete is a must in order to build a strong structure. Cement is important material in producing a good concrete. It act as binder or glue to bind all material which is aggregate and fines aggregate to become concrete. There were many types of cement but Ordinary Portland Cement (OPC) were commonly used in most every construction.

Steel Fibre Concrete increasingly been used in construction industry. Fibre were generally utilized in concrete to manage the plastic shrink cracking and drying shrink cracking. (Aggeliki K., 2011) They were many types of steel fibre such as hooked ends steel fibre, micro hooked ends steel fibre, and cooper coated steel fibre. Every type of steel fibre has different purposes such as micro hooked ends steel fibre were more suitable used for surface of high building and hooked end steel fibre widely used in construction field for concrete reinforcement as this type of steel fibre ensure the best status between steel fibre and concrete.

During the hardening of the concrete, hydration process occur inside the concrete. Hydration process were process to binding all the ingredient of concrete which are fine aggregate, course aggregate, cement and water. During this hydration process, cement reacted with water to produce one gel that act as a binding agent which is Calcium-Silicate-Hydrate gel (CSH gel). This gel will bind the ingredient of concrete and during hydration process, heat released. Based on Neville, 2011 heat that occur during hydration process, the quantity of heat of unhydrated cement that evolve upon complete hydration at a given temperature. The heat of hydration consists of the chemical heat of the reactions of hydration and the heat of adsorption of water on the surface of the gel formed by the processes of hydration.

From Figure 1.2, Malaysia known as one of the largest palm oil producer and exporter in the world after Indonesia and from Figure 1.3 it can be seen that the total 5.74 million hectare of palm oil plantation area in Malaysia with 2.68 million hectare at Peninsular Malaysia and 3.06 million hectare of palm oil plantation area at Sabah and Sarawak. To generate electricity, all the waste from palm oil residue such as fibre, shells and empty fruit bunches were burnt into the power plant and Palm Oil Fuel Ash (POFA) was biomass product of power plant (Jamo, Abdu, & Pahat, 2015). Then, POFA generally disposed to the landfill.

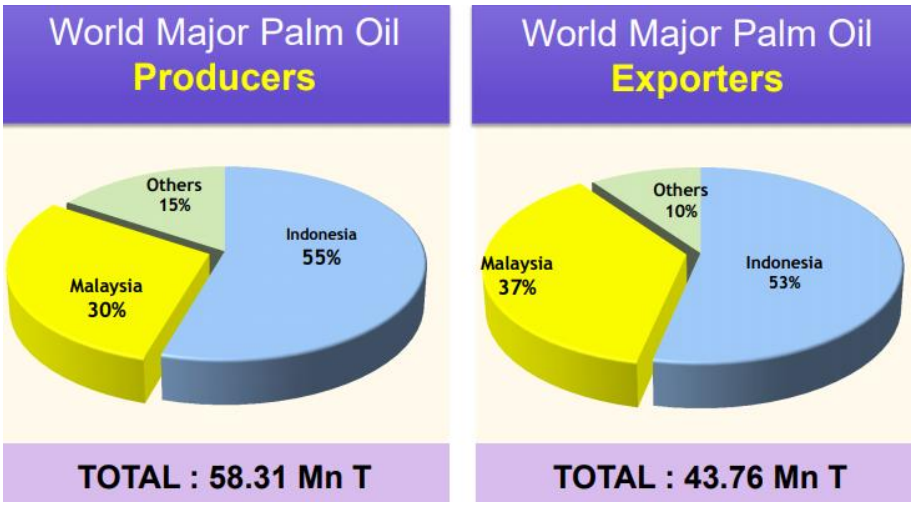

Figure 1.2 World Major Palm Oil Producers and Exporters

Source: (Din, 2017)

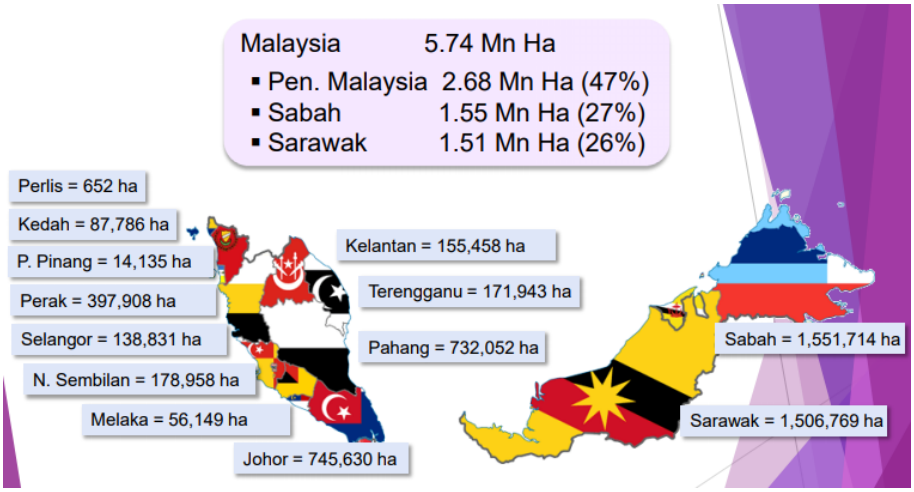

Figure 1.3 Oil Palm Planted Area in Malaysia

Source: (Din, 2017)

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